

## Patent Claims

1. External electrode for a multilayer piezoceramic actuator, characterised in that the external electrode (23, 24; 26; 27) consists of conductive material layers (19) and nonconductive material layers (22, 25) arranged alternately above one another, in that one of the two outlying conductive material layers (19) is connected to the base metallization (11) of the actuator (1) and the other is connected to the voltage supply lead (6), and in that the conductive material layers (19) are electrically connected to one another.
2. External electrode according to Claim 1, characterised in that it consists of at least two layers of a conductive material (19) and a layer of a nonconductive material (22, 25) arranged between them.
3. External electrode according to Claim 1 or 2, characterised in that each conductive material layer (19) consists of a metal foil.
4. External electrode according to Claim 3, characterised in that the foil (19) has a thickness of about 30  $\mu\text{m}$  to about 200  $\mu\text{m}$ , preferably between 50  $\mu\text{m}$  and 100  $\mu\text{m}$ .
5. External electrode according to Claim 3 or 4, characterised in that the foil (19) has a spatial structure, and in that the layer can therefore attain up to three times the thickness of the foil.
6. External electrode according to Claim 1 or 2, characterised in that the conductive material layers (19) are three-dimensionally structured.

7. External electrode according to Claim 6, characterised in that the conductive material layers (19) consist of metal gauze or fabric, of a mesh or of metal foam.
- 5 8. External electrode according to Claim 7, characterised in that the gauzes, fabrics or meshes of the conductive material layers (19) have a thickness of about 100  $\mu\text{m}$  to 200  $\mu\text{m}$ .
9. External electrode according to Claim 7 or 8, characterised  
10 in that the lattice widths of the fabrics or meshes of the conductive material layers (19) are between about 100  $\mu\text{m}$  and 200  $\mu\text{m}$ , and the wire diameter is between about 50  $\mu\text{m}$  and 100  $\mu\text{m}$ .
10. External electrode according to one of Claims 1 to 9,  
15 characterised in that the nonconductive material (22, 25) is a resilient plastic, preferably a thermoplastic such as polytetrafluoroethylene (PTFE) or polyimide.
11. External electrode according to Claim 10, characterised in  
20 that the nonconductive material (22, 25) is a plastic, in the form of films with a thickness of about 10  $\mu\text{m}$  to about 100  $\mu\text{m}$ .
12. External electrode according to one of Claims 1 to 11,  
characterised in that the conductive material (19) is coated  
25 with the nonconductive material (22, 25).
13. External electrode according to one of Claims 1 to 12,  
characterised in that the individual conductive material layers  
(19) consist of different metallic materials.
- 30 14. External electrode according to one of Claims 1 to 13,  
characterised in that the conductive material (19), at least of the layer which is soldered to the actuator material, has a

coefficient of thermal expansion matched to the ceramic material of the actuator (1).

15. External electrode according to one of Claims 1 to 14,  
5 characterised in that it is produced by colaminating the  
conductive material layers (19) and the nonconductive material  
layers (22, 25).

16. External electrode according to one of Claims 1 to 15,  
10 characterised in that the electrical connection between the  
conductive material layers (19) is established by via-contacts  
or contacts leading around.

17. External electrode according to Claim 16, characterised in  
15 that the conductive material layers (19) are respectively  
connected to one another on their long sides.

18. External electrode according to one of Claims 1 to 14,  
characterised in that the conductive material (19) is folded  
20 into a meandering or spiral shape, and in that the nonconductive  
material (22, 25) is respectively arranged between two  
superimposed layers of the conductive material (19).

19. External electrode according to one of Claims 1 to 14,  
25 characterised in that the conductive material (19) is bent into  
a C-shape, in that it encloses the nonconductive material layer  
(22), and in that the bent sides are connected to the base  
metallization (11) of the actuator (1).

30 20. External electrode according to one of Claims 1 to 19,  
characterised in that the conductive material (19) consists of a  
copper or silver alloy.

21. External electrode according to one of Claims 1 to 19, characterised in that the conductive material (19) consists of an iron-nickel alloy or an iron-nickel-cobalt alloy.
- 5 22. External electrode according to one of Claims 1 to 21, characterised in that it is connected to the base metallization (11) of the actuator (1) by soldering or by bonding with a conductive adhesive.